MEMORANDUM

To:	Kathy Parker, EPA William Ryan, EPA	**Date:**	May 29, 2013
From:	Mark Larsen, Anchor QEA, LLC Jeremy Porter, Aspect Consulting	**Site:**	Bremerton Gas Works
Cc:	Kalle Godel, Cascade Natural Gas		
Re:	Human Health Risk Screening Methods - Intertidal Beach Play Scenario: Removal Evaluation Work Plan		

Per your request, this memorandum describes the preliminary human health risk evaluation that will be used to support the Removal Evaluation for the Bremerton Gas Works Site (Site). The Removal Evaluation is being conducted consistent with the Administrative Settlement Agreement and Order on Consent (AOC) executed in May 2013 between Cascade Natural Gas and the U.S. Environmental Protection Agency (EPA). The Site is located at 1725 Pennsylvania Avenue in Bremerton, Washington.

The screening-level risk evaluation will be performed for the intertidal beach sediments adjacent to the former gas works. This preliminary analysis is intended for limited use as a screening step to assess the potential magnitude of human health risks associated with current beach conditions prior to implementation of the Remedial Investigation/Feasibility Study (RI/FS). A full baseline human health risk assessment (HHRA) and ecological risk assessment will be performed during the RI/FS, and that HHRA may supersede the screening-level risk evaluation.

The preliminary screening of human health risks will focus on potential risks associated with carcinogenic polycyclic aromatic hydrocarbon (cPAH) compounds in sediments. These compounds can be elevated in residuals associated with manufactured gas plant operations. They can also be present in petroleum hydrocarbons, combustion byproducts, treated wood structures and stormwater.

This evaluation will be conducted in coordination with the EPA considering potential child exposures under a beach play exposure scenario. This type of evaluation is reasonable considering the accessibility of the beach area to beach users. Beach play exposure scenarios have been evaluated recently by EPA at other marine sediment sites with similar accessibility and characteristics, including at the Lower Duwamish Waterway (LDW) Superfund Site. That analysis was summarized in the final HHRA performed during the RI/FS study process (Windward 2007).

The beach play exposure scenario will be evaluated using the same or similar assumptions as that used during the LDW HHRA. The materials attached to this memo illustrate the exposure and toxicity assumptions that were used as part of the LDW HHRA. These assumptions are being incorporated into the draft Removal Evaluation Work Plan (Work Plan; in preparation).

As we discussed during our recent teleconference, the LDW HHRA beach play scenario exposure parameters resulted in a risk-based threshold concentration (RBTC) of 9 milligrams per kilogram (mg/kg) total cPAH at the 10^{-4} risk level. Surface sediment analytical data for the LDW beaches were analyzed on a beach-by-beach approach. For the Bremerton Gas Works Site, the small intertidal beach area adjacent to the Site will be treated as a single unit. As with the LDW, comparison to the screening levels will be made on the basis of reasonable maximum exposure (RME) exposure. The RME exposure will be estimated using two methods:

- A 95 percent upper confidence limit on the mean (95 percent upper confidence limit [UCL]) calculated using individual sample data as determined by EPA ProUCL software. This is the EPA-prescribed method for establishing exposure point concentrations (EPC) in risk assessment.
- A 95 percent UCL calculated from the surface-weighted average concentration (SWAC) generated by geographic information system (GIS) software (e.g., ESRI ArcGIS) and inverse distance weighting (IDW) tools. This approach is consistent with the standard EPA EPC derivation method and provides a more robust way to address the average exposure across a spatially-explicit area. The IDW model will be optimized to account for the distribution of the data (i.e., log-normally distributed

data would be log transformed) and to minimize the error of the interpolated surface relative to the empirical sample data.

The risk screening and data evaluation steps will be performed in coordination with EPA. Please let us know if you have any questions regarding the attached information.

RISK SCREENING ASSUMPTIONS

These risk screening assumptions were developed for cPAH compounds using exposure assumptions consistent with EPA's recent risk evaluation of intertidal marine sediment cleanup areas within the Lower Duwamish Waterway (LDW) Superfund Site. These assumptions are included within the LDW RI/FS and Final Baseline Human Health Risk Assessment (Windward 2007).

RME estimates

- Developed for children from 0 to 6 years old
  - Scenario assumes children playing and digging in sand adjacent to the water.
- Exposure estimates are higher than for adults or older children
  - Higher incidental soil ingestion rate
  - Lower body weights
  - Health-protective for evaluation of other beach visitors
- Exposure via dermal contact and incidental ingestion of sediment
  - Exposure results from contact with moist sediment in intertidal areas.
  - Ingestion of marine surface water is assumed to be minimal.
- Exposure frequency 65 days per year
  - Exposure frequency is based on a King County survey of established parks (Lake Union, Lake Washington, and Lake Sammamish) with sandy beaches.
  - These King County park areas are likely to have higher visitation rates than the beach adjacent to the Bremerton Gas Works Site located on the Port Washington Narrows.
  - The Bremerton Gas Works Site and vicinity lack the amenities found at the King County parks (i.e., rest rooms, picnic tables, lawn, parking area).

Toxicity data

- Cancer slope factor (current value published in the Integrated Risk Information System database or IRIS) for benzo(a)pyrene is 7.3 milligrams per kilogram per day $(mg/kg\text{-}day)^{-1}$.

- The cPAHs are mutagenic compounds. An early-life stage adjustment is applied to account for mutagenic effects.
- Different cPAH compounds are evaluated together using the toxicity equivalency (TEQ) method. The total cPAH concentration is computed with individual cPAH weighted according to their benzo(a)pyrene toxicity equivalency factor (TEF; Collins et al. 1998).

Risk-based threshold concentration (RBTC)

- The LDW HHRA RBTC was 9 mg/kg total cPAH at the $1x10^{-4}$ risk level.
- The RBTC is intended to be applied to spatially-explicit exposure area, such as an individual beach.
- Exposure point concentrations are estimated using spatially weighted average concentrations (SWAC) calculated using commercial geographic information system (GIS) software and using inverse distance weighting (IDW) interpolation tools.
- Based on its small size, the intertidal beach area adjacent to the former gas works will be analyzed as a single exposure area.

Beach Play Risk Calculations

The following equations illustrate the calculations for the beach play exposure analysis. These calculations are consistent with the risk-based threshold concentration (RBTC) calculations developed for the Lower Duwamish Waterway Human Health Risk Assessment (LDW HHRA; Windward 2007 and Windward 2010). Attachment 1 provides relevant excerpts from the HHRA including daily intake calculations for dermal and incidental ingestion of sediment. This summary addresses the calculation for carcinogenic PAHs (cPAH) as contained in that document.

$$RBTC = \frac{TR}{\left[\left(Dermal\ Dose + Incidental\ Ingestion\ Dose \times \frac{ED_{0-2yr}}{6yr}\right) \times 10 + \left(Dermal\ Dose + Incidental\ Ingestion\ Dose \times \frac{ED_{2-6yr}}{6yr}\right) \times 3\right] \times SF}$$

Where

$$Dermal\ Dose = \frac{ABS \times AF \times FC \times EF \times CF1}{AT} \times \sum \frac{SAi \times EDi}{BWi}$$

and

$$Incidental\ Ingestion\ Dose = \frac{IR \times FC \times EF \times CF2}{AT} \times \sum \frac{EDi}{BWi}$$

The fixed input parameters to characterize exposure from incidental ingestion and dermal contact to sediment are provided in Table 1 and age dependent input parameters are provided in Table 2.

Table 1
Summary of Input Parameters and Values for the Beach Play Scenario

Input Parameter	Equation Code	Value
Target risk (unitless)	TR	1.0E-04
Absorption factor (unitless)	ABS	0.13
Skin surface area (cm^2)	SAi	Age-dependent. Refer to Table 2.
Adherence factor (mg/cm^2-day)	AF	0.2
Child soil/sediment ingestion rate (g/day)	IR	0.2
Fraction from contaminated site (unitless)	FC	1
Exposure frequency (days/year)	EF	65
Exposure duration (years)	EDi	1 for each age class. Refer to Table 2.
Incidental sediment ingestion rate (g/day)	IR	0.2
Body weight (kg)	BWi	Age-dependent. Refer to Table 2.
Averaging time, cancer (days)	AT	25550
Conversion factor, kg to mg (0.000001)	CF1	0.000001
Conversion factor, kg to g (0.001)	CF2	0.001
Cancer slope factor (mg/kg-day)-1	SF	7.3
Mutagenic adjustment factor (unitless)	Incorporated in Equation	Age-dependent. Refer to Table 2.

Notes:
cm^2 = square centimeters
g = gram
kg = kilogram
mg = milligrams

Table 2
Beach Play Scenario – Age-dependent Input Parameters and Values

Age Class	Skin Area (SA; cm^2)	Body Wt (BW; kg)	Mutagenic Adjustment (MA; unitless)
<1	1330	9.1	10
1 to 2	1750	11.3	10
2 to 3	2069	13.3	3
3 to 4	2298	15.3	3
4 to 5	2515	17.4	3
5 to 6	2751	19.7	3

References

Collins, J.F., J.P. Brown, G.V. Alexeeff, and A.G. Salmon. 1998. Potency Equivalency Factors for Some Polycyclic Aromatic Hydrocarbons and Hydrocarbon Derivatives. Regulatory Toxicology and Pharmacology 28: 43-54.

Windward, 2007. Lower Duwamish Waterway, Final Remedial Investigation, Baseline Human Health Risk Assessment.

Windward, 2010. Lower Duwamish Waterway, Final Remedial Investigation.